SURVEY OF IRRIGATION IN SELECTED NORTH CAROLINA COUNTIES, 1962

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SURVEY OF IRRIGATION IN SELECTED NORTH CAROLINA COUNTIES, 1962

A Summary of a Survey of Arrangements
by Irrigators for Sources of Water
in Selected Parts of North Carolina

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Note: Water Resource Papers 1-12 inclusive may be purchased as a set for $1.00.

Introduction

The first paper in this series of research reports introduced a research project concerning arrangements to secure sources of water in North Carolina.

In this, the second paper of the series, we will review and summarize the first major work unit of the project: a survey of irrigation arrangements covering eleven North Carolina counties. Details of the individual county surveys will be reported in the next ten numbered papers (Water Resource Papers 3 through 12), which will be published simultaneously with this paper. In addition to this paper and the individual county irrigation surveys, it is anticipated that one or more additional publications concerning irrigation will be issued during 1963 or 1964.

Objectives

The main objective here has been to collect information which will make possible an accurate evaluation of the existing structure of laws and institutions affecting water use in the State, and of its impact on the development of water resources. To this end information has been gathered concerning crops irrigated, the extent of irrigation, sources of irrigation water, legal arrangements made by irrigators to secure these sources, and disputes over the use of water. The survey was conducted mainly through interviews based on a questionnaire, a copy of which is reproduced in the appendix.

Territorial coverage

Eleven counties were included in the survey. Eight counties[1] were comprehensively surveyed; all known irrigators were contacted. Sample surveys were conducted in three counties: one[2] by selecting irrigators by random numbers and two[3] by interviewing the county's largest known irrigators and at least one irrigator in each farm community.

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[1]Buncombe, Henderson, Transylvania, Davidson, Forsyth, Guilford, Warren, New Hanover.

[2]Alamance.

[3]Rockingham, Pender.

These areas selected for study--embracing the three geographical regions of the State and typifying the major irrigated crops of North Carolina--include:

.A five county segment of the Piedmont, coinciding roughly with what is sometimes known as the "Seven Cities Region" (the Cities of Greensboro, Winston-Salem, High Point, Burlington, Lexington, Thomasville and Kernersville).

.A three county segment of western North Carolina, lying in the Upper French Broad River Basin.

.A two county coastal section (Pender and New Hanover).

.The County of Warren, sometimes classified as Eastern and sometimes as Piedmont, chosen because of large artificial lakes within or along its borders.

The study areas are depicted on the map at page 4.

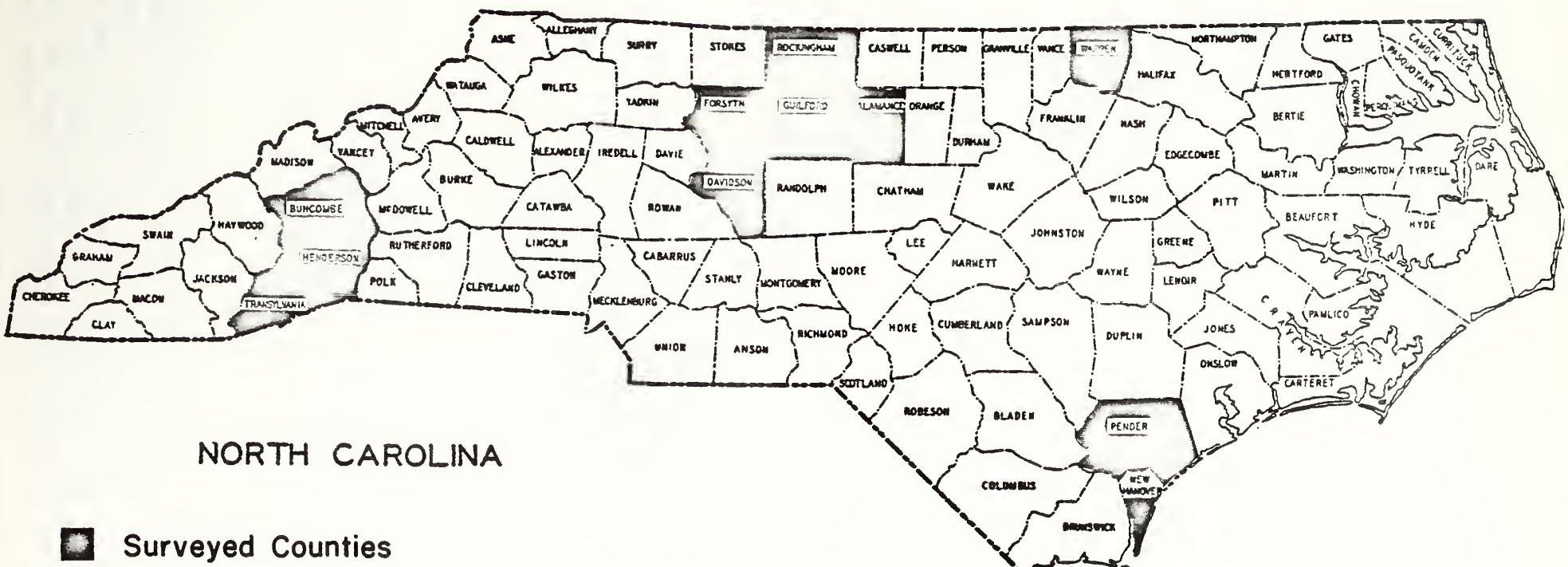
It should be noted that some large-scale individual irrigators were contacted in several other counties. Further such contacts will be made in 1963 and it is anticipated that a separate paper will be published concerning the implications of these unusual operations.

Survey methods

The data was collected by personal interview with irrigators in the survey areas, supplemented by discussions with local and statewide farm officials.

The initial step in surveying a county was to contact, usually by letter, the area's SCS unit conservationist several weeks prior to an appointment. On most occasions during the interview, general questions respecting irrigation in the area were discussed and a numbered list of known irrigators and a map locating them by corresponding numbers were obtained. After this working list was available, the surveyor called upon the county farm extension chairman to review the working list and for further suggestions. (Often the local SCS and extension officials had already reviewed the list together.) Upon completion of these interviews, the surveyor then either (1) contacted all of the suggested irrigators or (2) contacted only those designated as being the larger irrigators and others from each known irrigating community or (3) by a random selection visited a representative number of all of the irrigators in the county.

COUNTIES COVERED IN IRRIGATION SURVEY



NORTH CAROLINA

■ Surveyed Counties

With few exceptions the actual surveys indicated that the suggested lists were both up-to-date and comprehensive. (The surveyor made it a practice to ask the suggested irrigators for the names of other irrigators in their communities. Typically these inquiries produced few names not included on the prepared lists.)

Irrigation in North Carolina

Though North Carolina has an above average rainfall, there are critical periods to growers when several weeks of drought may determine success or failure for the season's crop. Thus inadequate rainfall after planting or during the normal growing period can be ruinous.

Irrigation on its current scale is relatively new to North Carolina, largely a phenomenon of the past 10-15 years. North Carolina soils and terrain are generally adaptable only to sprinkler irrigation, not to the ditch irrigation which prevails in the western states. Not until the post-war era was sprinkler irrigation made feasible by the development of lightweight, relatively inexpensive aluminum piping (as compared to cast-iron pipe). Sprinkler irrigation systems were first introduced to farming communities which had been hit by droughts of the early 'fifties and interest began to spread.

Since irrigation systems require a substantial capital investment even with the reduced cost of piping, and entail significant fuel and labor costs, ownership is generally limited to producers of such "money crops" as tobacco, flowers, nursery items, small fruits or truck crops and whose production level is high enough to bear irrigation's overhead. (There is also some irrigation of pasture, alfalfa, corn, and cotton.) Thus, with few exceptions, irrigation is only practiced on middle or high income per acre crops.[4]

Though primarily used to supplement natural rainfall, irrigation has other uses. Thus, tobacco farmers may irrigate their plant beds or their fields shortly after setting out their plants as a farming practice, regardless of the presence of drought, because it has been learned that watering

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[4]As an example, the average annual cost per acre of an irrigation system in North Carolina (both fixed and operating costs) may range in the neighborhood of $60 per acre for flue-cured tobacco. Variations are accounted for by such factors as the amount of pipe needed to bring water from the source, the investment in pumping equipment and storage, and the individual farmer's choice as between capital and labor costs. For further information see N. C. Agricultural Extension Service, Circular 439, "Costs and Returns of Irrigating Flue-Cured Tobacco."

at these times increases the likelihood of a successful crop. Blueberry growers may continuously irrigate their budding bushes in the early spring to protect them from late frosts. And flower growers may irrigate to protect blossoms against the effects of scalding summer sun.

Irrigation Water Sources

Four different sources of water are used for irrigation in North Carolina: farm ponds, streams, wells and reservoirs. Although some of the sources are better suited to one area than another, their use is fairly well dispersed throughout the State.

Ponds

Early North Carolina irrigators relied almost entirely upon streams for water, but they soon found that streams were subject to the same problem that they were attempting to solve, lack of water during droughts. There was also some danger of contracting crop diseases from infected streams. Furthermore, the use of streams for irrigation prompted rumblings from other water users who questioned the legal foundation of irrigation from streams.

For all of these reasons irrigators were spurred to seek more satisfactory sources of water. Many found an answer in the farm pond. It hedged against drought by storing winter surplus water for summertime use;[5] lessened the risk of disease; and somewhat strengthened the farmer's legal position.[6] In addition it had other positive merits. Pond construction costs were often more than offset by savings in pumping and pipe costs. Farm ponds catch water where it falls thereby aiding in soil conservation, providing a convenient water source, and creating limited recreation sites.

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[5]How effective the pond may be as a drought-hedge we do not attempt to say. Indeed, there has been no prolonged general drought since the inception of large scale pond-building for irrigation purposes.

[6]The farmer's legal position when he irrigates from a pond rather than a stream may be stronger in two ways.

First--as spelled out later in the text--a pond may be derived from surface drainage, or from (in the legal sense) a flowing stream, or from ground water. Although the law is not completely settled, it is at least arguable that if a pond is derived from surface drainage originating on ones own land, he may use it for whatever purpose he wishes, including irrigation.

Second, whatever the source of the pond, it may be harder for a complaining water user to make out a case against a pond irrigator than against a stream irrigator. He may have difficulty in proving the source of the pond. Also, the existence of the pond may complicate the task of proving the hydrologic effects of irrigation.

Little wonder that the farm pond has become almost as familiar a sight as once was the mule and hand plow.

In ten out of the eleven counties covered in this survey, which included counties in each of the State's three geographical regions, ponds were an irrigation water source. In the Piedmont counties surveyed, the farm pond is the chief irrigation water source. The average farm pond is one acre and is classified by three types in this survey: the surface pond, the continuous flow pond, and the excavated pond.

Surface pond: The surface pond relies entirely upon rainfall (surface runoff or drainage) as its water source. This pond is usually found in a low place on a farm near or in the field which it will serve. Though the surface pond is found throughout North Carolina, it is most often seen in the Piedmont where there are bountiful pond sites. It is also called variably a sky pond, a dry pond, a dry weather pond, or a dead pond.

Continuous flow pond: The continuous flow pond, as its name implies, draws not only upon surface runoff but also relies upon a continuous flow of water from another source, such as a spring, branch or stream.[7] Generally this type of pond is supplied by springs in the pond or by a branch beginning in a nearby spring, all of which are within the bounds of the farm. The continuous flow is found throughout the survey areas, especially in the Piedmont, where it is the most common type of farm pond. Sites for surface and continuous flow ponds are often indistinguishable unless clearly defined by a stream or a branch. This pond may be referred to also as a branch-fed, stream-fed, or spring-fed pond.

Excavated pond: The excavated pond--also called a dug pond, a dug hole or an excavated reservoir--is limited to portions of the State, principally the coastal plain region, where there is a high ground water level. Here the earth's surface is excavated or dredged deep enough to contact the ground water. Whereas the surface pond and the continuous flow pond are of varying sizes and shapes and are limited to suitable sites, the excavated pond is generally a long rectangular excavation whose only

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[7]In this paper we use the terms "branch", "stream", and "river" to refer (respectively) to a small, medium-sized and large watercourse. By a "branch", we mean to indicate flowing water in a defined course which may vary from a trickle out of a spring to several inches of moving water that may extend to several feet in width.

site requirement is the high ground water table. In the flat coastal plain this pond may also become a reservoir for field drainage, similar here to the surface pond. It may also derive its source of water from ditches leading to nearby swamps, or from streams or backwaters.

Streams

In the counties covered by this survey, rivers and streams are a secondary source of irrigation water in the Piedmont and East but they are the prime water source in the West. Here the streams flow abundantly from their mountain watersheds and thus far there have been no serious known conflicts over water. In other areas development of disease-resistant crops has been a factor in the continued use of streams as an irrigation water source, while pollution has eliminated some water sources otherwise available. Streams or backwaters also are used in the coastal plains. Therefore, like the farm pond, the stream also has statewide use as an irrigation source.

From streams that are relatively shallow and slow moving several techniques may be employed to impound enough water to provide the necessary volume required in irrigating. Building a temporary dam out of sand bags at a prior time can usually impound a sufficient volume. Another method, occasionally used both in the Piedmont and on the coastal plain, is very similar in practice to the excavated pond--the dredging of a hole beside a stream and diverting water into the hole. The hole size is small and is normally excavated by means of a farm tractor with an appropriate attachment; it is a temporary arrangement for obtaining water.

Wells

With isolated exceptions the use of wells as an irrigation water source was found to be limited to the coastal plain counties. There the high ground water table, allowing both shallow wells and deep wells, provides an irrigation water source that has few problems that must be considered in using ponds or streams. Fifty per cent of the irrigators reached in New Hanover and Pender Counties used wells either as their only source or in conjunction with the use of another source.

Reservoirs

By "reservoirs" we refer to artificial impoundments for public water supplies, hydroelectric power and multiple purposes. Reservoirs are the

IRRIGATION WATER SOURCES

This Chart Indicates What Percentages of the County's Respective Irrigators Are Using A Particular Water Source and the Percentage Using A Combination of Sources.

	Number of Irrigators	Ponds				Streams	Reservoirs	Wells	Other	Combination of Sources
		Continuous Flow	Surface	Excavated	Total					
MOUNTAIN										
Buncombe	34	17.6%	--	--	17.6%	91.2%	--	2.9%	--	11.8%
Henderson	44	25.0	--	--	25.0	84.1	--	--	--	9.1
Transylvania	4	--	--	--	--	100.0	--	--	--	--
Average		14.2%	--	--	14.2%	91.8%	--	--	--	7.0%
PIEDMONT										
Alamance	25	84.0%	48.0%	--	100.0%	4.0%	--	--	--	4.0%
Davidson	18	77.7	11.1	--	88.8	44.4	5.6%	--	--	33.3
Forstyh	32	81.2	6.3	--	84.3	37.5	--	3.1%	--	28.1
Guilford	109	90.8	29.3	--	99.1	3.7	--	.9	--	3.7
Rockingham	72	88.8	13.8	--	95.8	15.2	1.4	--	1.4%(1)	13.8
Warren	43	93.0	9.3	--	95.3	9.3	4.7	--	--	9.3
Average		85.9%	19.6%	--	93.9%	19.0%	2.0%	.67%	--	15.4%
EASTERN										
New Hanover	12	--	--	50.0%	50.0%	33.3%	--	75.0%	--	33.3%
Pender	16	37.5%	--	43.8	81.3	18.8	--	25.0	--	25.0
Average		--	--	46.9%	65.7%	26.1%	--	50.0%	--	29.1%

(1) City water from fire hydrant.

least used source for irrigation water source in the survey areas. Normally only riparian land owners will have access to the waters and this significantly limits the number of users.

Two situations were encountered where riparian owners had been granted permission, revocable by the city council, to irrigate from city reservoirs. In one of these cases (Reidsville), the permission had been obtained in the form of a deed condition; in the other (Burlington), in the form of an annual permit.

Similar situations prevail in Warren County. Some farmers who had sold land to VEPCO for Gaston Lake had reserved deed conditions permitting irrigation from this new reservoir. The Corps of Engineers has granted irrigation privileges from Kerr Reservoir by letter permits and permits. In Davidson County one large irrigator draws water from an industrial reservoir with the apparent acquiescence of the reservoir owner.

Regions

Mountain

With the high rainfall generally attributed to the mountain areas of North Carolina, one might ponder the need there for irrigation. This area, however, like the Piedmont and Eastern areas is susceptible to drought.

The primary crops irrigated in the three county survey area are truck crops, tobacco, flowers and occasionally pasture. The two largest applications were truck crops in Henderson and tobacco in Buncombe. All three counties had irrigators growing gladiolas; among flower growers irrigation is vital since flowers cannot withstand any sustained drought.

This area's primary water source is the mountain stream. Ponds with a continuous flow from a branch or spring are occasionally used but usually only where a stream is not readily available. The streams range from rivers down to swiftly flowing branches. No water use conflicts involving irrigation were reported in the area, though a dispute over water quality between the City of Asheville and a cabbage grower reached the State Supreme Court in the mid-fifties (Young v. City of Asheville, 241 N.C. 618, 86 S.E.2d 408 (1955)).

The irrigation trend in the area seemed fairly static, though twenty per cent of Henderson County's forty-four irrigators indicated that they might be giving up farming. Apparently this was a result of dissatisfaction with market prices for truck crops.

Piedmont

Mudpatched tobacco barns edge the now widened or paved rural roads of the Piedmont, their presence a memorial to the past, present, and hopefully the future of tobacco farming. The cultivators of tobacco are by far the prime users of irrigation in the Piedmont, though there is some irrigation of truck crops, pasture, alfalfa and nurseries.

Whereas streams provided irrigation waters in the mountains with only an occasional pond, in the Piedmont ponds are the leading water source with streams assuming a secondary role. The terrain of the Piedmont is particularly well suited to pond building. Most of the ponds are of the continuous flow type, though there are a large number of surface ponds also. It is not unusual to find a tobacco farm with several ponds, of one or both types, located near or between the fields that they will serve. In some isolated instances, wells or reservoirs were used as the irrigator's prime or supplemental irrigation water source.

Irrigation in this area seemed to have more vitality as an increasing practice than in other regions. More of the irrigators talked with enthusiasm and had recently purchased their systems, and more were planning to buy or had recently bought additional pipe or sprinklers. Others were buying or testing new sprinklers, such as the controversial big gun head, which is designed to cover as much as an acre at one setting.[8] Others, having systems sufficient to water their present allotments, reported that if their allotments were increased, their systems would be increased proportionately.

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[8] Only two farmers were interviewed who had acquired big gun sprinklers. In reply to an inquiry, the Agricultural Extension Service stated that this type of irrigation sprinkler is not suitable for North Carolina soils since water is applied at a much faster rate than the soil can absorb it, consequently causing excessive runoff. The Service also said that the so-called "one acre" at one setting aspect of the sprinkler head is misleading since the application on one acre is not uniform and that in most instances only one-third of an acre is adequately covered.

APPLICATION OF IRRIGATION (1)

	Number of Irrigators	Tobacco	Truck	Flowers	Nursery	Pasture
MOUNTAIN						
Buncombe	34	61.8%	14.7%	2.9%	--	20.6%
Henderson	44	--	79.5	6.8	4.5%	9.1
Transylvania	4	25.0	25.0	50.0	--	--
Average		28.9%	39.7%	19.9%	--	9.9%
PIEDMONT						
Alamance	25	100.0%	--	--	--	--
Davidson	18	72.2	5.5%	--	--	22.2%
Forsyth	32	59.3	6.3	--	6.3%	28.1
Guilford	109	92.7	1.8	--	3.7	--
Rockingham	72	100.0	--	--	--	--
Warren	43	97.7	2.3 (2)	--	--	--
Average		87.0%	2.7%	--	1.7%	8.4%
EASTERN						
New Hanover	12	25.0%	25.0%	33.3%	16.7%	--
Pender	18	56.3	12.5 (3)	31.3	--	--
Average		40.7%	19.9%	32.3%	--	--

(1) The figures recorded below represent the primary crop irrigation on the respective farm. Secondary uses are not reflected.

(2) There were 7 farms where truck crops were irrigated in addition to tobacco which was the number one crop.

(3) This figure includes one blueberry farm. There were other blueberry farms, but their operators could not be contacted during the survey.

Eastern

Comments on this region are of necessity limited since the survey area comprised only two of the coastal plain counties, New Hanover and Pender. In the Mountain and Piedmont regions surface waters were the primary irrigation sources, whereas in these Eastern counties more emphasis is placed on the use of ground waters, wells and excavated ponds. Though tobacco is still a leading crop the agriculture here is somewhat more diversified, with many instances of truck crops and flowers being cultivated. Some of the present irrigators indicated a desire to expand their systems; however, there was no clear indication that new systems were being rapidly purchased. Apparently the status quo is being maintained.

Other Findings

Survey findings not reflected in the earlier text or charts are summarized in the appendix under the appropriate questionnaire headings. Several of these items appear to merit specific mention at this point.

*Little useful information was obtained in response to questions concerning the amount of water used for irrigation. However, some answers can probably be synthesized from information on types of crops, acreage, size of sprinklers, amount of piping, and quantities of labor used. Some further efforts may be made along these lines in later phases of this project.

The Engineering Extension Department of North Carolina State College estimates that the average usage per acre on irrigated flue cured tobacco in North Carolina is approximately as follows: 85,000 to 90,000 gallons per acre per year based on an average of 2 1/2 applications per year.

The Engineering Extension Department has also furnished us the following approximate estimates of water use per acre on various crops.

Tobacco--3 to 6 acre-inches per year (recommended minimum design standard for ponds, 12 acre-inches of water per acre of tobacco).

Flowers--Eastern: .2 to .3 acre-inches per day for crop cooling, May through September. Western: approximately 12 acre-inches per year.

Blueberries and strawberries--10 to 12 acre-inches per year.

Nurseries--18 to 24 acre-inches per year.

Alfalfa, pasture and other hay crops--12 to 15 acre-inches per year (recommended minimum design for water source, 18 acre-inches of water per acre of cropland).

Truck crops--Variable, depending on area of State, number of crops grown per year, and other factors. Average water usage probably 6 to 8 acre-inches per year.

Turf (e.g., golf courses, lawns, and cemeteries)--Golf courses will probably average 18 to 24 acre-inches per year for tees and greens, 12 to 18 acre-inches per year for fairways. (Probably about one-fourth of the golf courses will irrigate fairways.)

Corn, cotton and peanuts--Limited irrigation, no estimates of water usage available at this time.

*As indicated in the appendix, very few irrigators in the survey areas have found it necessary, in order to secure their sources of water supply, to acquire water rights or riparian lands or to enter agreements concerning the use of water. The few exceptions involved permissive use of ponds by neighbors, or shared ponds where costs were split or the use of land exchanged for pond construction work, or (in one instance) a trading of timber rights for an easement to build a pond for irrigation and other purposes.

*The almost complete absence of reported disputes over water use involving irrigation is also worthy of note.

TRENDS IN IRRIGATION

	Number of Irrigators	Possible Expansion	Possible Reduction	Acquisition of Equipment '61/'62
MOUNTAIN				
Buncombe	34	5.9%	8.8%	--
Henderson	44	9.1	20.1	--
Transylvania	4	--	--	25.0%
Average		5.0%	9.6%	--
PIEDMONT				
Alamance	25	20.0%	4.0%	28.0%
Davidson	18	11.1	--	11.1
Forsyth	32	3.1	--	6.5
Guilford	109	25.7	3.7	21.1
Rockingham	72	22.2	--	22.2
Warren	43	11.6	4.7	20.9
Average		15.6%	2.1%	18.3%
EASTERN				
New Hanover	12	33.3%	8.3%	16.6%
Pender	18	18.8	--	12.0
Average		26.1%	--	14.3%

Conclusions

One hesitates to venture any firm conclusions concerning irrigation at this early stage of an over-all research project and before other contemplated studies of irrigation have been completed. However, a few tentative observations are appropriate, subject to later correction if they prove unwarranted.

(1) The variety of sources of water used for irrigation is noteworthy and, within this variety, the emphasis upon farm ponds of various kinds. This variety is a factor to be taken into account in any evaluation of irrigation as a water use and in any future law-making concerning water use. The trend toward use of farm ponds is of interest because, as noted earlier, it tends to strengthen the legal foundation for irrigation.

(2) Also worthy of notice is the rather long list of crops which apparently benefit, in varying degrees, from irrigation and the several different applications of irrigation in North Carolina--as drought insurance; as a means of strengthening young plants; as a form of frost protection; and as a way to protect flowers against summer sun. All of these factors, like the variety of irrigation water sources, should be taken into account in any future law-making on the subject of water use.

(3) The absence of reported disputes arising from irrigation suggests that irrigation in these areas has not yet been in serious conflict with other water uses. At least two precautions come to mind, however. First, one would hardly expect irrigators to emphasize their own role as a source of water-use conflicts. A more complete picture may emerge from surveys of other types of water users. Second, this survey has been conducted at a time when there has been no recent extended drought to serve as a genuine test of the potentiality for conflict.

(4) Subject to similar qualifications, the survey tends to suggest that, by and large, irrigators in the study areas are able to live under the existing legal structure without serious difficulty. This we infer from the fact that (a) few irrigators have found it necessary to make any special legal arrangements in order to secure sources of water, and (b) where special arrangements have been called for (e.g., permits, contracts or easements) the existing legal structure has been able to supply them.

(5) Irrigation is a new feature on the landscape of North Carolina. It has apparently grown rather rapidly (as does anything that starts from zero) and its growth trend continues to point upward. This paper, however, has not focused specifically on the over-all role and long-term prospects of irrigation in North Carolina--a subject which we hope to cover in greater detail in a later phase of the project.

Acknowledgments

This survey would not have been possible without the generous co-operation we received from farmers and from agricultural officials. The help given us by SCS Unit Conservationists and from the County Extension Chairmen in the survey counties was particularly vital. It would have been well-nigh impossible to identify and locate irrigators without their assistance. At the statewide level, we are especially grateful to State Conservationist Richard M. Dailey of SCS and Howard Ellis of the State College Department of Engineering Extension for helping to pave our way, for useful background information, and for review of drafts of this and other papers in the series. The opportunity to work with them and their able staffs is always an event to be anticipated with high pleasure.

APPENDIX

FARM IRRIGATION WATER SUPPLY QUESTIONNAIRE

(April 1961, revised June 1962)

Note: Results of survey which are not reflected in the text of this paper are summarized under the appropriate questions. The summarized answers used are underscored.

1. What is your source of irrigation?
   a. 1. Pond 2. Reservoir 3. Stream 4. Well
   (See text and charts)

   b. Where is it located?
   In almost all cases the source was reported to be located on the property of the irrigator. The few exceptions involved streams or ponds located along property lines, or ponds located on neighboring farms, or large reservoirs.

2. What is your source of stock watering, if any, and domestic water?
   While the source of irrigation water often doubled as a source of stock water, wells or ponds or streams not utilized for irrigation commonly were used for stock water; wells, for domestic water.

3. Irrigation system.
   a. Describe The average system consisted of approximately 18 sprinklers and could cover one acre per setting (subject to terrain). Two farmers, both in Alamance, were found to be owners of the "machine-gun" sprinkler, which is rated for one-acre coverage.

   b. Type crops irrigated (See text and charts)

   c. Acreage (See text and charts)

   d. Amount of water used (days or am't) None of the farmers interviewed knew or was willing to estimate his water usage.

   e. Any mechanical device used to measure water No mechanical measuring devices were found, except in the case of one farmer who was using metered water supplied by the City of Reidsville (see U.N.C. Water Resource Paper No. 7).

4. If you irrigate from a stream, reservoir, will it float boats or canoes?
   The answers here were typically in the negative, excepting some of the larger rivers, the reservoirs, and the coastal watercourses.

5. Do you have a permit of any kind from the State or Federal Government for your irrigation operations? Answers typically negative, with exceptions which have been described in the text in the case of city water supply reservoirs and reservoirs controlled by Federal agencies.

6. Expansion of irrigation system
   a. Plans (Yes or No) (See text and charts)

   b. If not, do you expect your present source of water to be adequate? Answers here were almost invariably in the affirmative.

   c. If you had to go to a new source, what problems would be involved (water rights or access right)? This question produced almost no information, few of the irrigators having ever considered the matter.

   d. If you had to go to a new source where would you go? Ditto.

   e. Do you plan to reduce your irrigation operations? The responses to this question are reflected in the text. The most common reasons for reduced irrigation were sale of land or subdivision in urbanizing areas, and reduced farming operations because of old age or inability to obtain tenants.

7. a. Surface water sources:

      1. Do you own the bed of the pond, reservoir or stream that is your source of irrigation supply? Usually "yes", with exceptions indicated under question 1(b) above.

      2. Do you own any adjoining, or upstream or downstream land? (describe) Typically "no", except where farmers owned the bed and banks of branches or small streams to their sources.

   b. Ground water sources:

      1. Do you own the land overlying the well that is your source of irrigation supply? Uniformly "yes".

      2. Any adjoining land? (describe) No useful answers.

   c. Have you ever bought any water rights, or made any agreements with other water users concerning your or their use of water, because of your irrigation operations? When, where and at what cost? Answers reflected in text. Virtually no cases of buying water rights were encountered.

8. Have you been involved in any law suits or disputes settled out of court growing out of complaints against your irrigation operations, or in which you brought suit against other water users? No litigation was reported, and few indications were given of disputes of any kind. Those disputes or conflicts reported dated from the drought period of the mid-fifties.

9. a. If you irrigate from a pond, reservoir or stream, is it used for any purpose other than irrigation? Usually "no", except in cases of multipurpose or water supply reservoirs and some of the larger rivers. As to ponds: while most ponds had been stocked with fish at one time, insecticides and the like often took their toll of fishlife. Boating or swimming were not reported to be common, this being understandable in view of the small average size of ponds (i.e., one acre).

b. If so, identify--stock water, fishing, swimming, boating, city or industrial water supply, electric power generation. Answers here were self-evident.

c. Do you have any control over these uses, and if so, how? Typically "no", except in the case of ponds located on personally owned land.

d. Are there any conflicts or disputes because of these competing uses? A few pollution problems were specifically noted, but other than these, no conflicts or disputes were mentioned.

10. Have you paid anything to acquire flowage easements, stream or reservoir beds, riparian lands and water rights in connection with irrigation? How much? Only one example of this was reported (a swapping of timber rights for an easement in Rockingham County).

11. Are you satisfied with your legal rights to use water for irrigation purposes under existing water rights law? Most of the irrigators who responded to this question appeared satisfied with their rights--though, whether out of an ignorance or an awareness of their actual rights is not clear.

12. What effect did recent droughts (e.g., fall 1961, May 1962) have on your irrigation practices? The "droughts" of recent years, if they may be so termed, did not appear to have had any marked effect upon irrigation trends.

13. What new irrigation equipment have you bought this year? Answers reflected in text and charts.